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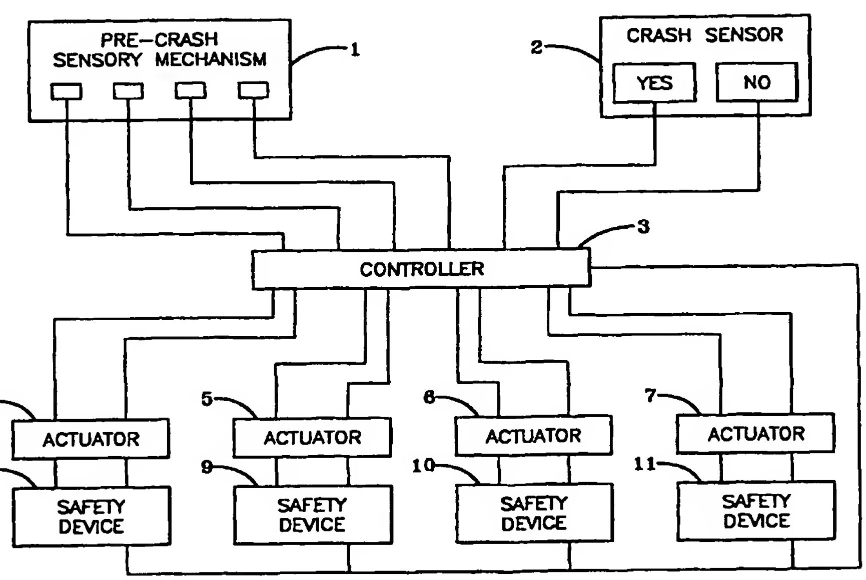
(54) Title: PASSIVE SAFETY SYSTEM FOR A MOTOR VEHICLE



(57) Abstract: A passive safety system for a motor vehicle has a plurality of safety devices (8-11) that are movable by associated drives from a normal state into a crash-induced safety state. The passive safety system also includes a precrash sensor system (1) that can actuate one or more safety devices to a safety intermediate position and then as a function of the subsequent driving situation the respective safety device (8-11) is brought into the safety state and is kept in the safety state or is brought back to the normal state.

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PASSIVE SAFETY SYSTEM FOR A MOTOR VEHICLE

The invention relates to a passive safety system for a motor vehicle with a plurality of safety devices actuable by associated drives and with a precrash sensor system that determines the probability of a crash.

A vehicle's passive safety system may include, for example, seat belts with belt tensioners, belt force limiters, adjustable seat ramps in the substructure of vehicle seats, adjustable steering columns, adjustable pedals, adjustable combinations of backrest and headrest on vehicle seats, adjustable roll bars, airbags, and the like The passive safety system may comprise not only safety devices for protecting the vehicle occupants but also safety devices for protecting persons outside the vehicle.

It is also desirable to provide a vehicle with a precrash sensor system to detect hazardous driving situations prior to a crash. A computer determines the probability of a crash and the safety devices on the vehicle are activated accordingly.

With known safety systems it is necessary to bring the safety device into the corresponding safety position or safety state within a short period of time in the event of a crash to protect the vehicle occupants or persons outside the vehicle.

According to the invention, each safety device of the passive safety system is designed in such a way that it is movable toward the safety state that it adopts in the event of a crash, at least to a safety ready state for imminent deployment and can be brought

back reversibly from this safety ready state into the normal state which it adopts during normal travel. A controller controls various safety devices of an automobile and delivers signals to them so that the safety devices are moved momentarily, for example for half a second or longer, into the safety ready position. The safety devices are then moved into the deployed state, which it adopts in the event of a crash, or are brought back into the normal state in the absence of a crash.

For the reversible actuation of the safety devices, the drive with which the respective safety device is brought into the deployed state required in the event of a crash can be actuated. However, it is also possible to provide an additional drive which brings about the reversible movement of the safety device into the ready position and back from there to the normal state.

The invention saves a considerable amount of time for bringing the corresponding safety devices into their final deployed state in a crash.

Critical situations that can be detected by the precrash sensor system include, for example, emergency braking, skidding, the deflection and/or rebound of a respective wheel, the angular velocity of steering and different coefficients of friction on the wheels relative to the roadway. Precrash sensors can also detect external risks of a crash such as objects approaching the vehicle.

If, for example, the controller determines a dangerous situation exists, the seat belt system on each occupied vehicle seat can be brought into a ready state. This is preferably accomplished by an electric

motor that acts, for example, on the belt reel of the seatbelt retractor or, to increase the restoring force of the motive spring of the seatbelt retractor. A brushless d.c. motor of the type known, for example, from DE 43 02 042 A1 or DE 197 31 689 C2 is preferably used for this purpose.

Furthermore, the belt height adjuster of a three-point seat belt can be adjusted in height by an electric motor during critical situations. This can take place in conjunction with a movement of the belt tensioner in its ready position. This also applies, in particular, in connection with an inflatable safety belt system of the type described, for example, in DE 198 04 65.

In addition to the movement of the seat belt into the ready position, for example with the aid of the tensioner drive or an additional associated drive (i.e. electric motor drive), it is advantageous also to adjust the back rest of the vehicle seat by an electric motor to bring the vehicle occupant into an ideal body position (about 21°) for a frontal crash. This can be accomplished, for example, by an electric motor drive of the type described in DE 43 02 042 A1.

In addition to the backrest, the seat substructure, in particular the seat base can also be adjusted to adjust the inclination for the pre-crash adjustment. In particular with the risk of a frontal impact, it is advantageous to adjust the top inclined position of the seat base, preferably with the aid of an electric motor drive. A brushless d.c. motor of the type known from DE 43 02 042 A1 is also suitable for this reversible adjustment. Components in the interior of the motor vehicle such as steering

columns, pedals, instrument panel, or a deforming element in the knee region can also be designed to travel reversibly so that they can be brought momentarily into their deployed positions.

For passive protection in crashes involving persons outside the vehicle, actuators can be actuated reversibly by the controller, which can determine the proximity of pedestrians by a radar. To minimize injuries to pedestrians, vehicle components such as bumpers, lateral body parts, vehicle roofs, momentarily can move into an energy-absorbing state. Vehicle components can therefore be brought intentionally into a state of readiness in which they act in an energy-absorbing manner during a collision involving persons outside the vehicle.

With early detection of a possible side impact crash, the respective safety devices used for tensioning the seatbelt, for optimizing the sitting position (seat base, back rest, head rest) are momentarily brought into their respective ready positions. Side plates in the seat substructure can additionally be driven into an upper position. Parts of the door trim, for example the armrest, can be moved momentarily to have adequate space for the airbag on inflation.

If a rear crash is threatened, the correct position of the headrest is essential for minimizing the consequences of the crash. An optimized body position for avoiding or reducing consequences resulting from a rear crash is achieved by an electric motor adjustment of the inclination of the back rest combined with the adjustment of the head rest as described, for example, in DE 199 31 894 A1. For

Brief Description of the Drawings

Fig. 1 is a block diagram of a passive safety system of a motor vehicle according to the invention.

Figs. 2 through 6 show first through fifth embodiments, repectively, of a safety device.

Fig. 7 is a side view of the embodiment of the safety device shown in Fig. 6.

Fig. 8 shows a sixth embodiment of a safety device.

example, the headrest can be tilted forward momentarily or the headrest can be driven forward and upward with respect to the position of the backrest, as described, for example in DE 199 31 894 A1. The seatbelt tensioner can also be actuated in such a way that the belt slack, formed as a result of the relative backward movement of the occupant in relation to the backrest, is removed. Positioning of the vehicle occupant in an optimized position is thus achieved before the occurrence of a rear crash. If no rear crash occurs, the components which are momentarily brought into their deployed positions, namely the back rest, the head rest and the seat base, are brought back into their normal positions. An electric motor drive of the type described, for example, in DE 43 02 042 A1 is also suitable for the reversible movement.

Actuators, in particular high performance actuators, on detection of a vehicle roll, can also make the reversible adjustments of the seat belt system.

High-power actuators driven by electric motor are preferably used which produce a rotational or linear movement to bring about the necessary reversible adjustment of the respective safety device.

Detailed Description of the Invention

Fig. 1 is a block diagram of a passive safety system having a precrash sensor system 1 with a plurality of precrash sensors which provide, for example, information concerning emergency braking, skidding, different coefficients of friction between the roadway and the individual vehicle wheels, the rebound of a respective vehicle wheel or the angular velocity of steering. External sensors can also be provided for early detection of potential crash causing hazards. Corresponding sensor signals are transmitted to a controller 3. A crash sensor 2 transmits signals to the controller in the event of a crash. If no crash occurs, the crash sensor can deliver a corresponding signal to the controller after a certain time lapse, calculated from the occurrence of the precrash signals, for example 0.5 to a few seconds.

The controller 3 controls the actuation of various safety devices 8, 9, 10 and 11. The respective safety device can be a belt tensioner, an adjusting device for a belt webbing height adjuster, an adjusting device for adjusting the position of the head rest relative to a vehicle back rest, a back rest adjuster, a seat ramp adjuster, an adjuster for the pedals and/or steering column or the like. The safety devices 8 to 11 can have integrated drives which move the respective safety device in the event of a crash from a normal state prevailing during normal travel into the crash-induced deployed state.

The safety devices 8 - 11 are designed in such a way that they can be moved reversibly, at least into a

ready state directed toward the crash-induced deployed state. This reversible movement or adjustability of the safety device 8 - 11 can be brought about by the integrated drives which can operate pyrotechnically, mechanically, for example by spring force, electrically, for example by an electric motor or magnet, pneumatically or also hydraulically actuatable. The safety devices 8 - 11 can also be associated with additional actuators 4 - 7 as shown in Fig. 1. The actuators 4 - 7 bring about the reversible movement of the respective safety device into the ready state or deployed state and back into the normal state.

The controller 3 preferably evaluates the precrash signals coming from the precrash sensor system 1, using a computer. If the evaluation shows a critical driving situation that may lead to a frontal impact, side impact, rear crash, or roll over, the controller activates at least the safety devices involved in ensuring the safety of the vehicle occupants in the event of a crash of this type. For this purpose, the safety devices are momentarily brought into their deployed state, or moved into a ready state in the direction of the deployed state, by the integrated drives or the associated actuators 4 - 7. If the crash sensor 2 does not detect a crash after the short time has elapsed, for example about 0.5 seconds or more, the respective safety device is brought back from the deployed state or the safety ready state into the normal state.

The actuators 4 - 7 that reversibly adjust the safety devices can be operated pneumatically, hydraulically, mechanically (for example by spring

force) or electrically, in particular by a magnet or an electric motor with a rotary drive or linear drive (preferably an electric motor or electromagnet).

Figs. 2 - 8 show various actuators for producing the reversible adjusting movements in the safety devices.

In Fig. 2 an electric motor drive 12 is provided which, via a gear 13, is able to move a belt reel 14 of a seat belt retractor reversibly in the direction of the deployed state by pretensioning the safety belt wound on the belt reel 14 (not shown in detail)and back again.

The electric motor drive 12 may also adjust a fixing point 15 of a motive spring 16 of the belt retractor preferably acting directly on the belt reel 14. A pinion 17 resting on the motor shaft can have a rotary drive connection, for example via the gear 13, to the fixing point 15. The gear 13 is preferably designed as a self-locking gear, for example a worm gear or planetary gear, and acts as a rotational speed-reducing gear. The fixing point 15 for the motive spring 16 can be adjusted reversibly between its normal position and the deployed position or the ready position. The spring force with which the motive spring 16 acts on the belt reel 14 and therefore on the applied safety belt webbing can be increased momentarily by adjusting the fixing point 15 and can then be brought back into the normal state. The spring force can also be increased in such a way that the motive spring 16 forms a mechanical energy store for power tensioning of the seat belt in the event of a crash.

In the embodiment shown in Fig. 3, a pyrotechnically driven seatbelt tensioner drive 22, of the type known, for example, from DE 44 22 980 C2 is adjusted reversibly. A pressure store 19 which can be connected to the respective working chamber 31 of a rotary piston or drive wheel 18 via a valve 20 is used for this purpose. The pressure store 19 can be refilled at any time by a motor-driven pump or compressor 21. A clutch transmits the rotational movement of the drive wheel 18 to the belt reel in a known manner during the movement of the seatbelt tensioner drive by the pressure medium, for example compressed gas, stored in the pressure store 19 or by centrifugal force during the rotation. The belt webbing is momentarily loaded with a specific pull by the rotational movement. If there is no crash, the valve 20, which is preferably actuated electromagnetically, is closed again. The clutch (coupling) disengages so that the belt reel is freely rotatable again relative to the drive wheel 18 of the tensioner drive. A different rotor for the tensioner drive, which can be driven by a propellant gas, can also be used instead of the drive wheel. A hydraulic pressure medium can also be used instead of a pneumatic pressure medium. In this case, hydraulic fluid can be brought back from a reservoir 32 via a line 44 to the pump 21, forming a circuit. There is a non-return valve 30 between the pump (compressor) 21 and the pressure store 19.

In the embodiment shown in Fig. 4 safety belt webbing 23 is guided away from the belt retractor 24 between two jaws 25, 26 which can be set into rotation, for example by an electric motor. This

causes the seat belt 23 to be momentarily tensioned until a specific pull is attained (ready state) during rotation of the jaws.

In the embodiment shown in Fig. 5 a piston 33 of the tensioner drive 22 for a belt buckle 29 is momentarily brought into a ready state by an electric motor drive 12. This causes a specific increased pull to be exerted on the seat belt webbing for a specific period of time, for example up to five seconds. The motor drive 12 is connected to the piston 33 via a traction cable 45. In the event of a crash the tensioner drive 22 is actuated, for example pyrotechnically, and the piston 33 is driven so far in the guide tube 34 that the belt buckle 29 and therefore the seat belt webbing are tensioned in the deployed state. If no crash occurs, the piston 33 is brought from its ready position back into its normal position by a compression spring 35. The belt buckle 29 is then back in its normal position.

In the embodiment shown in Figs. 6 and 7, an electric motor drive 12, which can be arranged on a vehicle seat on one or both sides, acts via a transmission shaft 38 on a back rest 37 of the vehicle seat. The output shaft of the electric motor drive 12 transmits the torque produced by the electric motor drive 12 to an adjusting gear 39 known per se, which is connected to the back rest frame 40. The stator of the electric motor drive is supported on the seat frame 41. The electric motor drive 12 can be designed as a flat-frame motor of the type known, for example, from DE 43 02 042 A1. If the risk of a crash, in particular a rear impact, is detected by the precrash sensor system 1 the electric motor drive 12 is

activated. Thus the backrest 37 is brought from a normal position shown in solid lines in Fig. 7 into a safety deployed position shown in broken lines. The headrest 42 can also be adjusted simultaneously in that it is moved forward and upward. The back rest 37 can also be brought into the safety deployed position shown in broken lines in Fig. 7 if there is a risk of a frontal impact. If after a certain period of time, for example about five seconds, no crash occurs, the electric motor drive 12 is activated again and the back rest 37 and the head rest 42 are brought back into their normal positions.

In the embodiment shown in Fig. 8 the tensioner drive 22 has a toothed rack 35 that is driven by a pyrotechnic drive 36 in a guide tube 34 for tensioning a seat belt. The toothed rack 35 acts on a drive wheel 28 that is connected directly or via a gear to the belt reel of a belt retractor. This power tensioning takes place when a crash occurs. A power tensioner with toothed rack drive is known, for example, from EP 0 629 531 A1.

The action of the electric motor drive 12 on an additional toothed rack 27 is controlled as a function of signals from the precrash sensor system 1. For this purpose, the electric motor drive 12 rotates a threaded spindle 43 that engages with an internal thread of the toothed rack 27. The toothed rack 27 is moved upward in Fig. 8 by this operation, so that the seat belt wound onto the belt reel, not shown in detail, is pretensioned by the rotation of the drive wheel 28. Belt slack can be removed, for example, from the seat belt, or the vehicle occupant can be brought from out-of-position into a preferred position

in which the risk of injury is reduced. If no crash occurs, the toothed rack 27 is brought back into its normal position by the electric motor drive 12. If a crash occurs, the pyrotechnic propellant 36 is ignited and the toothed rack 35 deploys to accomplish the power tensioning.

CLAIMS:

1. A passive safety system of a motor vehicle with a plurality of safety devices which are movable by respectively associated drives from a normal state into a safety state in the event of an accident, a precrash sensor system with which the probability of an accident can be determined, and a controller that activates one or more safety devices as a function of the signals delivered by the precrash sensor system, characterised in that the respective safety device (8-11) is movable in the direction toward its safety state at least to a safety intermediate position and can be brought back reversibly from this safety intermediate position into the normal state and in that, as a function of the precrash signals, the controller (3) actuates drives (4-7) for a brief movement of the respective safety device (8-11) into at least the safety intermediate position and in that, then as a function of the subsequent driving situation, the respective safety device (8-11) is brought into the safety state and is kept in the safety state or is brought back to the normal state.

2. The passive safety system according to claim 1 wherein the reversible movement of the respective safety device is produced pneumatically, hydraulically, electrically or mechanically.

3. The passive safety system according to claim 1 or 2 wherein the energy store for producing the reversible movement is refillable.

4. The passive safety system according to one of claims 1 to 3 wherein an electric motor drive is provided for the reversible movement of the safety device.

5. The passive safety system according to one of claims 1 to 3 wherein the respective drive for the safety device can be operated reversibly.

6. The passive restraint system according to one of claims 1 to 5 wherein at least one of the safety devices (8 -11) is designed as a seat belt system with a tensioner drive (22) and in that, during the movement of the seat belt webbing (23) into the safety intermediate position, a specific pull which is maintained for a specific period of time is exerted on the belt.

7. The passive restraint system according to claim 6 wherein the specific pull is maintained for about 5 seconds.

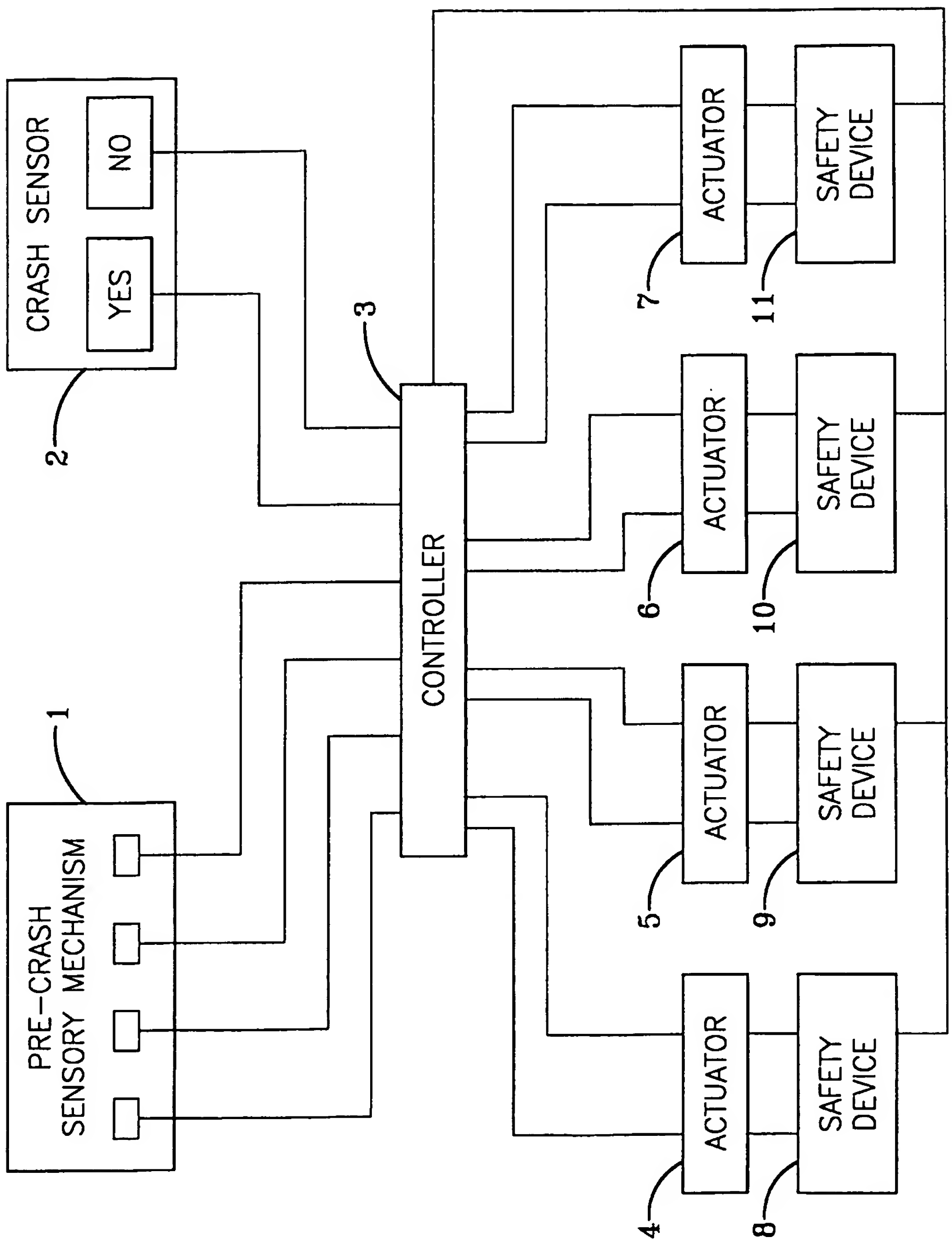
CRASH SENSOR
YES
NO
2
3
CONTROLLER
PRE-CRASH SENSORY MECHANISM
1
ACTUATOR
ACTUATOR
ACTUATOR
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FIG-1

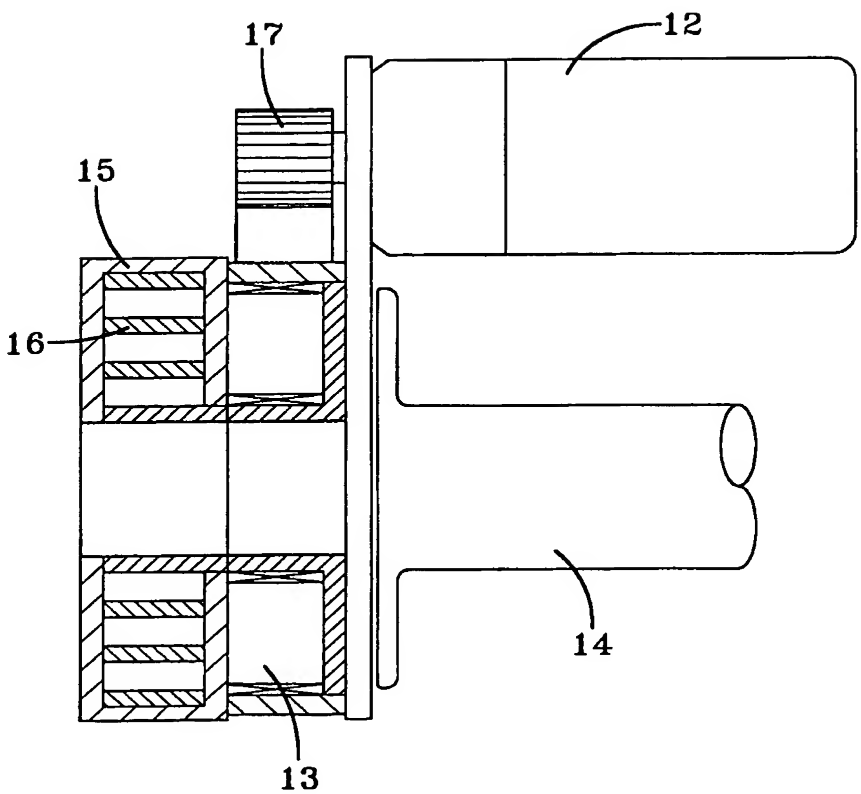
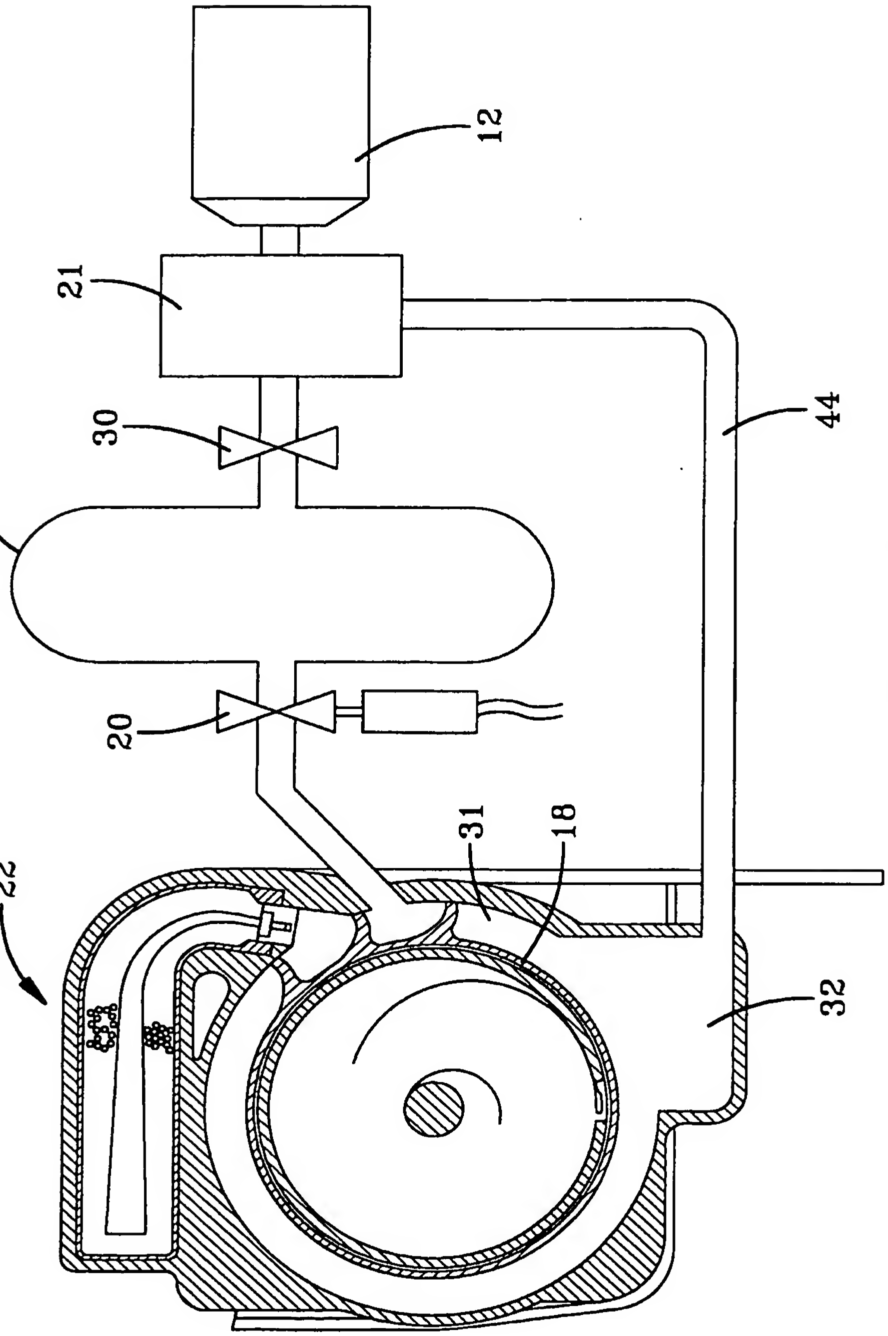
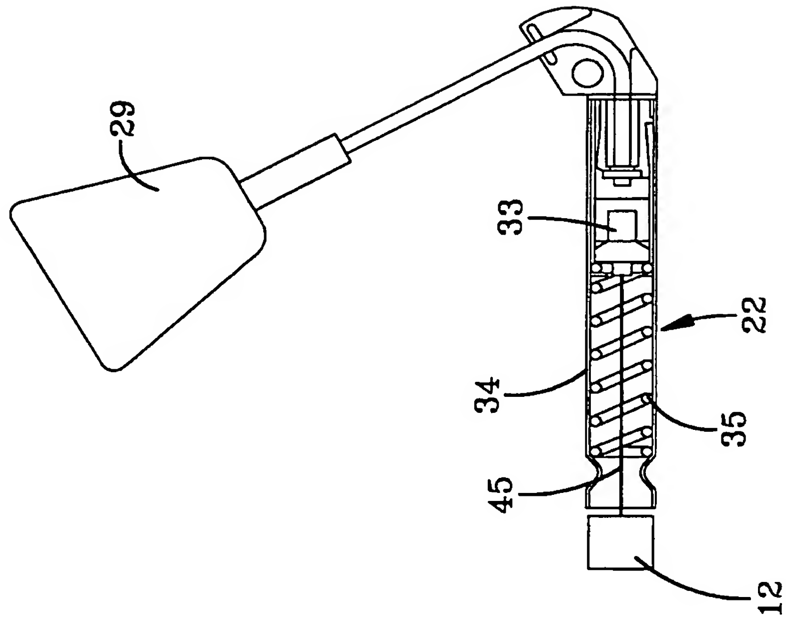


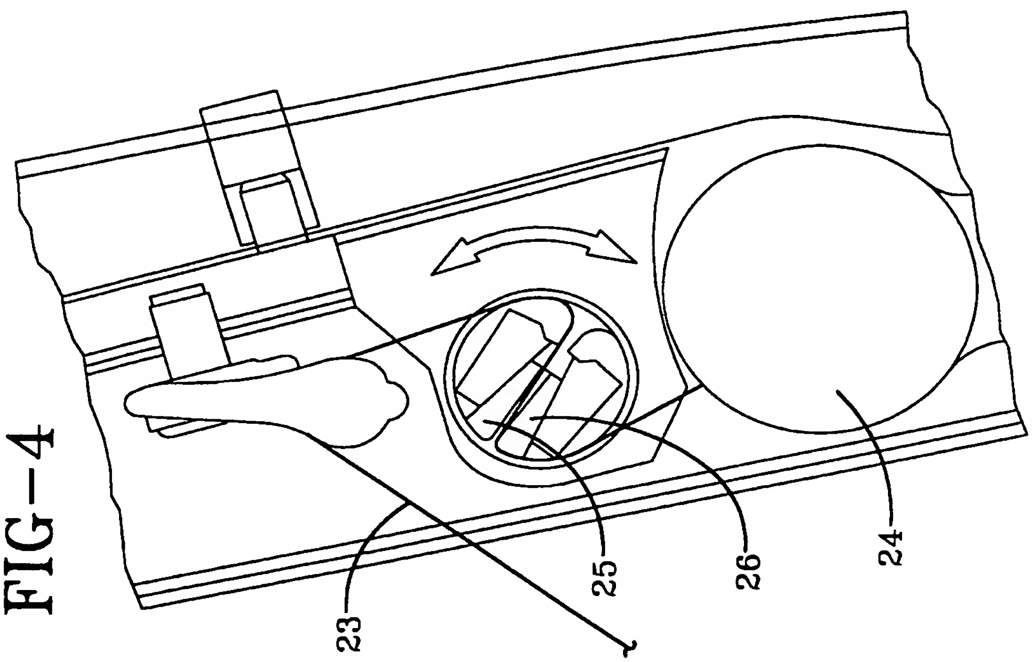
FIG-2



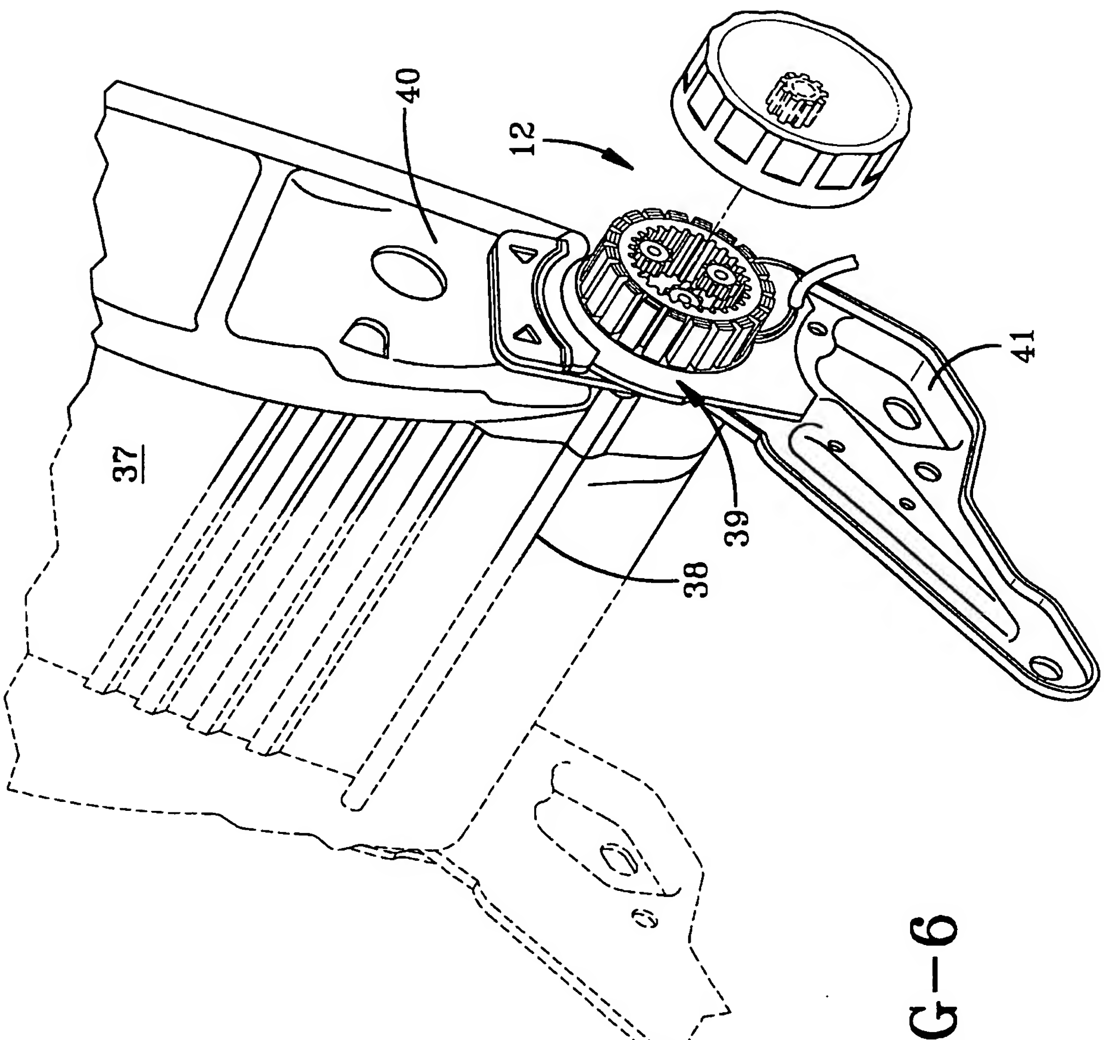
FIG—3



FIG—5



FIG—4



FIG—6

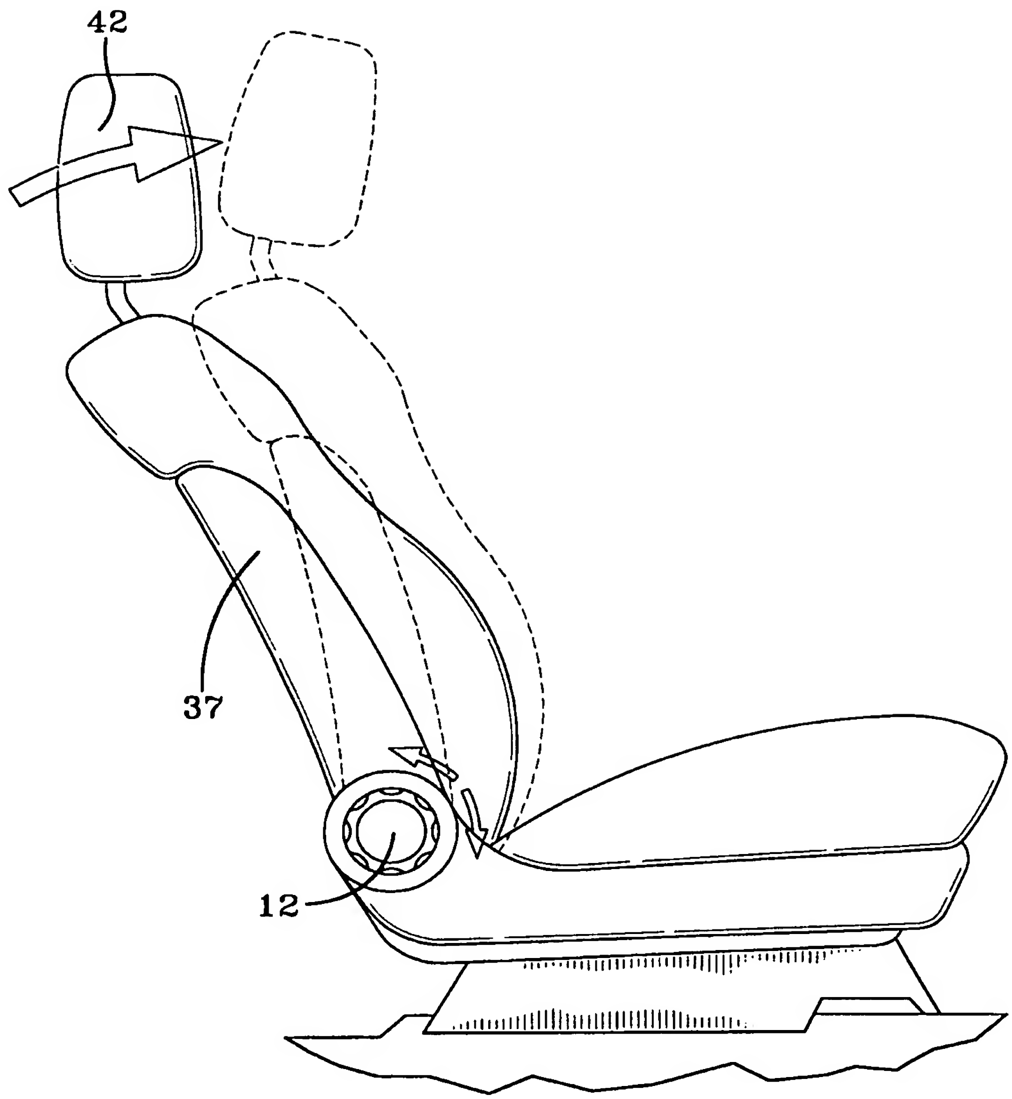


FIG-7

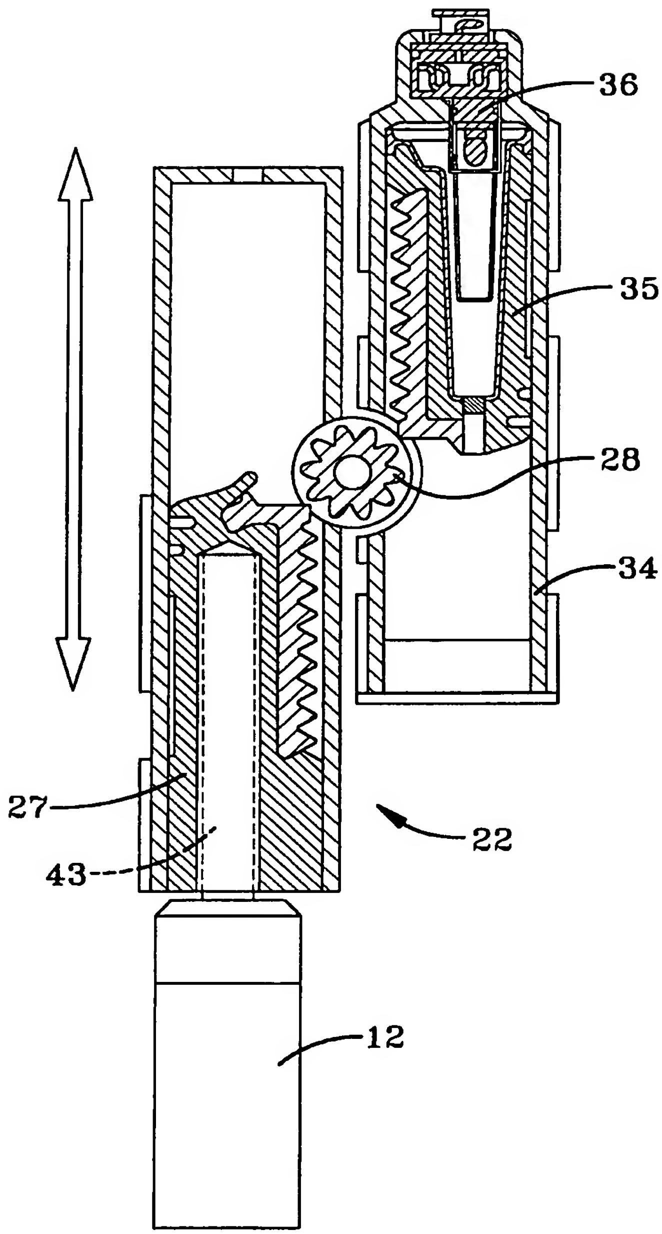


FIG-8

INTERNATIONAL SEARCH REPORT

International Application No
PCT/US 00/20236

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 B60R21/01 B60R22/46 B60R22/195 B60N2/427

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 B60R

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 552 986 A (KOBAYASHI MASAAKI ET AL) 3 September 1996 (1996-09-03) column 2, line 35 -column 7, line 10; figures 1A-2 column 17, line 30 - line 49; figure 22	1-7
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X	US 5 558 370 A (BEHR LEONARD W) 24 September 1996 (1996-09-24) column 4, line 48 -column 6, line 9; figures 1,3,4	1-6
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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

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Date of the actual completion of the international search	Date of mailing of the international search report
6 November 2000	13/11/2000

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Dubois, B

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INTERNATIONAL SEARCH REPORT

International Application No
PCT/US 00/20236

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
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INTERNATIONAL SEARCH REPORT

Information on patent family members

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